ROYAL ASTRONOMICAL SOCIETY.

Vol. XI. *June* 13, 1851. No. 8.

Lieut. Henry Raper, R.N., Vice-President, in the chair.

Wm. Francis, Esq., 9 Chadwell Street, Myddleton Square;
Rev. Joshua Sortain, Brighton;
Henry John Doogood, Esq., 13 Fortress Terrace, Kentish Town;
Henry Mugridge, Esq., Nautical School, Greenwich Hospital;
Hugh Neill, Esq., 115 Mount Pleasant, Liverpool;
Richard Dunkin, Esq., 20 Matilda Street, Islington;
Lieut. Andrew St. John, Royal Engineers; and
Rev. W. L. Onslow, H.M.S. Hastings;

were balloted for and duly elected Fellows of the Society.

Astronomische Nachrichten.

Several gentlemen who ordered the *Astronomische Nachrichten* for the current year, on the understanding that it was to be delivered free of postage, have complained that the back numbers have been sent in such a way as to cause a very heavy postage. Dr. Petersen committed the very excusable mistake of thinking that the post-office would deliver the numbers made up into *one* parcel on the same terms as it delivers the *several* numbers. Many deliveries are thus saved, but the authorities reason differently. To obtain the benefit of the recent regulations the *form* must be strictly complied with, and *each* number must be sent with a *separate* direction. The Editor has to apologise in his own name and in that of Dr. Petersen for this mistake, which cannot, however, occur again.*

The Editor would earnestly press on those gentlemen who have imperfect copies of the *Nachrichten* to apply for the missing numbers. The vols. i. and iii. are not to be had entire, and there is only one entire copy of vols. ii., iv., vii. Copies of the volumes

* It is not easy to make out the rules even of our own post-office, and still less those of foreign nations, by any method but that of trial and error, and even then not always satisfactorily. The last Annual Report went quite free to Altona with a penny stamp, but a copy to which a twopenny stamp was attached (the number being a heavy one) cost *2s. 6d. though sent to the same address.* The numbers of the *Astronomische Nachrichten* are delivered gratis at Somerset House, but cost a halfpenny at the Athenæum.

antecedent to vol. xii. are very few in number. There is, however, a considerable mass of odd numbers, and it is very desirable that these should find their proper places as far as may be, and as soon.

Comet-Circular received from Dr. Petersen.

"On the night of the 27th of June last, Dr. D'Arrest, of the Leipsic Observatory, discovered a very faint comet in the constellation *Pisces*. The apparent place could only be estimated very approximately on account of the twilight which shortly after ensued.

1851.	Leipsic M.T. h m	R.A. o ′	Decl. o ′
June 27	13 10	7 49	+10 32

This may be a few minutes in error.

"Next night was cloudy, and the comet invisible; but the night after proved more favourable, and Dr. D'Arrest obtained two comparisons with Weisse $0^{h}\cdot690$, which he considers as accurate as can be fairly expected considering the extreme faintness of the comet.

1851.	Leipsic M.T. h m s	R.A. o ′ ″	Decl. o ′ ″
June 29	13 14 5	10 4 47	+10 37 35

The comet has also been observed at Berlin and South Villa.

	1851.	h m s		R.A. o ′ ″	Decl. o ′ ″
Berlin,	July 1	13 21 29	Berlin M.T.	12 18 40·3	+10 40 28·5
South Villa,	4	13 4 59	Green. M.T.	15 37 32·0	+10 48 20·0

Elements. By MM. G. Rümker and E. Vogel.

Perihelion Passage, 1851, July 6·14735, Berlin M.T.

	o ′ ″	
Long. of Perihelion ...	324 19 44	App. Equinox,
— Node	152 40 44	1851, July 6.
Inclination	14 39 36	

Log. Perihelion Distance (log. q) 0·089026. Motion direct.

IRENE.

On the Discovery of a Fourth New Planet, at Mr. Bishop's Observatory, Regent's Park. By Mr. Hind.

"At $12^{h}\ 45^{m}$ mean time, on the night of the 19th of May, 1851, during an examination of the heavens near the star Lalande 29490, I remarked an object of very nearly the same degree of brightness, following the star $8^{s}\cdot5$ in right ascension, and about $2'\frac{1}{2}$ to the *south*. I had previously (in 1850) had my attention directed to a star of the 9·10th magnitude, which follows Lalande's about 10^{s},

and 2′ to the *north*, and consequently was pretty well convinced that no star of the 9th magnitude then occupied the position of the stranger, as it could not have been overlooked; the region of the heavens in the 16th hour of right ascension, and between 10° and 15° south of the equator, is one with which I am very closely acquainted, and to this familiarity with the telescopic stars gained by repeated examinations in 1847, I must attribute the discovery of a fourth planet, as I have before had occasion to attribute to it the detection of the new star in *Ophiuchus*, found on the 27th of April, 1848.

"The low power which was on the telescope at the time was immediately changed for the wire-micrometer, and comparisons of the suspicious object with Lalande's star were commenced at $12^h\ 51^m\ 54^s$ mean time, when the difference of right ascension was $8^s{\cdot}3$. At $13^h\ 4^m\ 53^s$ mean time, the difference was found to be $7^s{\cdot}7$, a change quite great enough to be beyond doubt, and from this time numerous differential observations were taken with the view of ascertaining the direction of the planet's motion, for of the planetary nature of the newly-discovered object I was now convinced.

"A mean of the whole gave for $13^h\ 9^m\ 30^s$ Greenwich time,—

Right ascension of planet greater than that of star.... $7^s{\cdot}52$
Right ascension of planet south of the star .....2′ 36″·1*

"On the night of the discovery it was remarked that there was a decided contrast between the light of the star and that of the planet; the former was very white and vivid, while the latter had a dull bluish tinge. The planet also appeared to be enveloped in an extremely faint nebulous atmosphere, the existence of which has been confirmed on several subsequent occasions, though it requires a perfectly clear night and great attention to render it very evident.

"Sir John Herschel, who kindly undertook the selection of a name for this, the fourteenth member of the ultra-zodiacal group, has suggested *Irene* as one suitable to the present time, the symbol to be a dove carrying an olive-branch with a star on the head; and since the announcement of this name, I have been gratified in receiving from all quarters the most unqualified expressions of approbation.

"There is one remarkable circumstance in the history of the discovery of *Irene*, which shows how closely the heavens are now examined, and how observers at distant stations, and without any

* Mr. Main, in the absence of the Astronomer Royal, has been good enough to send me the following places of Lalande 29490.

"The mean place of Lalande 29490, with which star Mr. Hind first compared the planet, is as follows, from five observations:—

	R.A.	N.P.D.
	h m s	° ′ ″
1851·0	16 4 0·51	103 20 56·4

"The Apparent Place on May 19 is

R.A.	N.P.D.
h m s	° ′ ″
16 4 2·10	103 20 56·9

communication with each other, are guided by experience into the same methods for prosecuting a search for planets. I allude to the independent discovery of the new planet by Dr. De Gasparis at the Royal Observatory of Naples, only *four days after my own*, intelligence of which reached London on the morning of Wednesday last, the 11th of June.

"The elements of *Irene* have been calculated by MM. Vogel and George Rümker, and their orbit represents the observed places up to June 10 with great accuracy. It places *Irene* between *Parthenope* and *Egeria* in order of mean distance from the sun, the period of revolution being 1490 days, or 4·08 years. The positions of the lines of nodes and apsides, and of the plane of the orbit, agree nearly with those of the orbit of *Ceres*.

"It is worthy of notice that a star of the 9th magnitude, observed by Bessel in zone 249, right ascension (1825), $16^h\ 4^m\ 21^s{\cdot}81$, north polar distance $= 104°\ 32'\ 26''{\cdot}9$ has disappeared from its place, which is little more than 1° distant from the position occupied by *Irene* at the time of her discovery. Unless, however, the period of revolution assigned to this planet by MM. Vogel and Rümker admits of a large correction (which at present seems improbable), I think the object observed by Bessel, though in all probability a planet, was not the one just brought to light. A month or six weeks' longer observation of *Irene* may furnish elements which will enable us to decide this point."

Observations.

	Liverpool. Greenwich M.T.	R.A.	Log $\frac{p}{P}$	N.P.D.	Log $\frac{q}{P}$	Star of Comp.
1851.	h m s	h m s		° ′ ″		
June 10	12 34 40·4	15 43 42·60	+8·292	104 12 21·3	−9·9559	γ Libræ
	12 58 36·8	41·86	+8·367	23·2	·9520	—
	13 32 33·2	40·90	+8·426	28·5	·9475	—
15	10 29 46·2	15 40 14·12	+7·333	104 28 10·2	·9651	—
	10 54 42·5	13·56	+7·820	13·7	·9642	—
	11 19 38·4	12·79	+8·041	16·6	·9628	—
16	9 55 17·2	15 39 37·18	−7·509	104 31 31·7	·9652	—
	10 20 13·1	36·24	+7·099	35·7	·9653	—
	10 45 9·2	35·65	+7·758	39·4	·9648	—
17	10 11 42·0	15 38 60·00	+6·731	104 35 6·7	·9656	—
	11 1 34·2	58·66	+7·975	14·4	·9636	—
July 16	9 55 10·3	15 33 41·92	+8·269	106 46 0·1	·9634	B.A.C.5257
	10 37 5·8	42·08	+8·398	7·8	·9556	—
17	9 59 27·7	15 33 56·47	+8·298	106 51 20·6	·9624	—
	10 19 25·3	56·43	+8·361	23·7	·9587	—
18	10 19 46·1	15 34 12·82	+8·373	106 56 47·2	·9580	—
	10 39 44·5	13·16	+8·423	47·8	·9536	—
21	10 12 55·2	15 35 11·14	+8·381	107 13 8·0	·9581	—
	10 32 53·9	11·46	+8·430	13·2	−9·9536	—

The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by p and q. P is the equatoreal horizontal parallax.

The following are the assumed *mean* places of the stars of comparison for 1851·0, derived from the Greenwich 12-year Catalogue:—

	R.A.	N.P.D.
	h m s	° ′ ″
γ Libræ	15 27 11·83	104 17 19·49
B.A.C. 5257	15 45 20·87	106 17 15·98

GREENWICH. Meridian Circle. (The Astronomer Royal.)

1851.	Green. M.T.	R.A.	N.P.D.
	h m s	h m s	° ′ ″
May 28	11 31 38·3	15 55 15·16	103 39 10·0
29	26 44·2	54 16·87	41 15·0
30	21 51·2	53 19·64	43 23·0
31	16 58·6	52 22·77	45 39·5
June 2	11 7 15·8	50 31·44	50 23·9
4	10 57 36·6	48 43·85	103 55 20·9
16	10 1 20·3	39 36·92	104 31 33·4
17	9 56 47·9	39 0·41	35 3·1
19	9 47 47·9	15 37 52·02	104 42 13·0

Not corrected for parallax.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

1851.	Greenwich M.T.	App. R.A.	Log $\frac{p}{P}$	App. N.P.D.	Log $\frac{q}{P}$	No. of Comps. in R.A.	No. of Comps. in N.P.D.	Set.
	h m s	h m s		° ′ ″				
June 10	12 11 41·1	15 43 43·32	+8·210	104 12 13·3	−9·9628	24	8	11
12	12 10 4·4	42 14·37	·240	18 31·7	·9624	12	4	12
15	11 11 19·7	40 13·14	·005	28 18·5	·9672	7	7	13
	12 16 44·9	11·33	·315	23·6	·9594	18	6	14
16	11 25 10·6	39 34·53	·123	31 42·9	·9656	24	8	15
17	11 51 12·0	38 57·35	·258	104 35 18·0	·9622	12	4	16
26	11 41 29·8	34 43·54	·354	105 10 16·4	·9588	24	8	17
	12 6 5·9	42·86	·415	18·6	·9540	23	8	18
28	11 42 53·3	34 5·63	·382	18 46·6	·9573	8	4	19
29	11 20 51·8	33 49·46	·332	23 5·3	·9607	20	7	20
	11 48 24·3	49·32	·405	12·2	·9554	12	6	21
30	11 19 46·9	33 35·04	·343	27 31·5	·9601	23	8	22
July 4	11 22 0·8	15 32 54·97	+8·393	105 45 56·4	−9·9573	17	6	23

P is the equatoreal horizontal parallax in seconds of arc; p and q are the required corrections in time and arc respectively.

Mean Places of Stars of Comparison, 1851·0.

Name,	R.A.	N.P.D.	Set.
	h m s	° ′ ″	
Weisse, xv^h, 864	15 44 56·62	104 15 51·5	11, 12
— 838	43 16·56	24 31·5	13
B.A.C. 5188	35 4·90	104 33 40·0	14, 15, 16
Weisse, xv^h, 644	33 40·03	105 5 5·7	17
B.A.C. 5190	35 41·85	11 39·0	18, 19, 20
— 5184	15 34 23·60	105 31 57·7	21, 22, 23

June 12. Sky clear for a very short time.
15, 16. High wind. The hearing tube used on the 15th.
17. Much interrupted by cloud.
28, 29. Planet very faint.
July 4. No choice of stars. Diff. of N.P.D. large.
5 to 14. Continued cloudy weather. Obs. discontinued.

Collegio Romano. Meridian Circle. (Father Secchi.)

1851.	Rome M.T. h m s	App. R.A. h m s	App. Decl. ° ′ ″
May 29	11 26 54·4	15 54 18·93	−13 41 17·8
30	22 1·5	53 21·77	43 20·3
31	17 8·9	52 24·89	45 38·5
June 1	12 17·0	51 28·77	47 56·1
2	7 26·3	50 33·77	50 19·8
3	11 2 36·4	49 39·72	52 44·3
5	10 52 58·8	47 53·60	13 57 48·2
6	10 48 15·6	15 47 1·88	−14 0 36·3

Micrometrical Observations.

1851.	Rome M.T. h m s	R.A. Planet. m s	Decl. Planet. ′ ″		Obs.	Microm.
May 31	11 39 7·7	=✱+2 31·7	=✱−5 3·4	48 Libræ	3	Circ.
June 1	9 15 14·8	+1 41·5		— —	3	Circ.
	11 40 17·8	+1 35·08	−2 43·7	— —	4	Wire
2	9 21 16·2	+0 44·78	−0 36·1	— —	5	Circ.
	9 53 54·8	+0 43·50	−0 33·3	— —	3	Wire
	11 34 55·4	+0 39·27	−0 23·3	— —	4	Wire
3	9 34 29·8	−0 10·39	+1 42·6	— —	3	Circ.
	11 52 44·7		+1 52·8	— —	4	Wire
	11 54 39·6	−0 15·53		— —	4	Wire
5	9 35 41·3		✱+0 17·3	H.C. 28969	3	Wire
	9 54 31·2	+0 0·2		— —	4	Circ.
	10 52 58·8	−0 2·7		— —	Mer. Passage	

Hamburg. (M. C. Rümker.)

1851.	Hamburg M.T. h m s	R.A. ° ′ ″	Decl. ° ′ ″	
June 4	10 22 43·5	237 10 45·8	−13 56 32·8	Equatoreal
	10 57 42·0	41·4	41·6	Merid. Circle
18	10 52 0·2	234 36 14·2	14 38 45·3	Equatoreal
19	10 47 29·9	27 59·5	42 23·0	—
21	10 40 46·5	234 12 27·8	14 49 52·3	—
28	11 34 57·4	233 31 33·8	15 18 48·1	—
29	11 13 52·6	27 35·9	22 54·3	—
30	10 58 51·8	23 58·4	27 17·7	—
July 1	10 57 56·6	20 46·1	31 42·3	—
2	10 53 24·8	18 4·8	36 22·1	—
3	11 23 22·7	233 15 51·3	−15 40 53·8	—

Not corrected for parallax.

HAVERHILL. (Mr. W. Boreham.)

1851.	Greenwich M.T.	R.A.		N.P.D.		No. of Obs.	Star of Comp.
	h m s	h m s	s	° ′ ″	″		
May 21	11 0 2	16 2 14·89	−0·012 P	103 26 25·6	−0·904 P	6	*a*
22	11 6 40	1 14·25	·012	28 1·1	·903	6	*a*
23	10 33 51	16 0 16·60	·013	29 41·2	·903	7	*b*
28	11 15 39	15 55 16·33	·003	39 10·8	·911	5	*b*
30	11 16 28	53 19·59	·000	43 21·8	·912	3	*c*
31	10 21 14	52 25·22	·009	45 32·9	·908	6	*c*
June 1	10 31 25	51 28·14	·006	47 52·3	·911	5	*c*
4	10 28 31	48 45·00	−0·005	103 55 16·0	·912	6	*c*
16	11 55 2	39 34·33	+0·020	104 31 44·8	.898	5	*d*
17	11 33 46	38 57·28	·017	35 8·0	·904	5	*e*
19	10 31 36	37 50·65	·009	42 26·3	·916	3	*f*
21	10 47 27	36 48·81	·012	49 57·5	·913	5	*f*
22	10 26 30	36 20·62	·009	104 53 46·1	·916	6	*f*
24	10 37 42	35 28·51	·013	105 1 47·0	·914	5	*g*
26	10 20 36	15 34 44·09	+0·012 *p*	105 9 59·1	−0·916 *p*	6	*g*

P = horizontal equatoreal parallax in arc.

	Mean Places, 1851·0. R.A.	N.P.D.
	h m s	° ′ ″
a = Weisse xvi^h, 38	16 2 43·22	103 35 54·3
b = — xv^h, 1118	15 58 46·02	40 0·5
c = Greenwich 12-year Catalogue, 1308	49 51·10	103 50 43·2
d = Weisse xv^h, 744	38 44·80	104 46 7·6
e = — — 705	36 37·41	41 56·6
f = Greenwich 12-year, No. 1282 = B.A.C. 5188	35 3·95	104 33 39·7
g = — — — 1283 = — 5190	15 35 41·86	105 11 38·8

Elements.

Calculated by M. Fergola, of the Royal Observatory, Naples.

Epoch 1851, June 1·0, Greenwich M.T.

	° ′ ″	
Mean Anomaly	44 5 32·3	
π	185 27 33·4	Mean Equinox of Epoch.
Ω	87 16 29·6	
i	8 52 28·6	
φ	8 50 10·5	
Log a	0·4078482	
μ	867″·4298	

The elements are based upon Mr. Hind's observation of May 19, and the Neapolitan observations of May 25 and June 3.

By Mr. R. C. Carrington, of the Durham Observatory.*

"From Hind's first observation and the Durham observations of May 31 and June 15 I have computed the following approximate Elements by the method of Gauss, carried to two approximations to P and Q:—

1851, June 1·0.

Mean longitude	M =	227° 43′ 36″·66	Mean Equinox. Jan. 0.
Longitude of perihelion	π =	180 42 49·74	
— ascending node.	N =	87 2 39·04	
Inclination	I =	9 0 18·20	
Angle of excentricity	φ =	9 28 10·80	
Mean diurnal motion	μ =	858″·1956	

"Residual errors.

	Computed—Observed Places.		
R.A.	−0ˢ·55	+0ˢ·55	+0ˢ·43
N.P.D.	+1″·17	+1″·05	+0″·92

"Heliocentric co-ordinates. (u = excentric anomaly.)

$x = [0\cdot4055744]\ \sin(u + 270^\circ\ 40'\ 3''\cdot98) + 0\cdot4185795$

$y = [0\cdot3670459]\ \sin(u + 184\ 42\ 30\cdot08) + 0\cdot0314439$

$z = [0\cdot0390821]\ \sin(u + 161\ 1\ 46\cdot50) - 0\cdot0585202$

By Mr. Norman Pogson, from the following Observations:—

1851.	R.A. h m s	N.P.D. ° ′ ″	
May 21	12 5 41·8	16 2 11·99	103 26 28·5 Cambridge.
31	10 53 59·1	15 52 23·74	103 45 38·0 Liverpool.
June 10	12 58 36·8	15 43 41·79	104 12 24·4 Liverpool.

Mean Anomaly ...		48° 13′ 33″·72	June 1, 0ʰ Greenwich M.T.
π		178 37 41·88	Mean Equinox, June 1ᵈ·0ʰ.
Ω		86 50 1·60	
i		9 6 22·08	
φ		9 47 20·75	
e		0·1700220	
Log a		0·4126288	
Log q		0·3316958	
Log μ		2·9310634	
μ		853″·2248	

Sidereal period, 1518·94345 days.

The middle observation is represented in longitude within +0″·42, and in latitude within −0″·08; Observed − Computed place.

---

* "Mr. Carrington wishes to call the attention of those Fellows of the Astronomical Society who may call at the Society's apartments to a model which he left there some months ago of the orbits of the *Asteroids*, then 13. His object in doing so was to illustrate a certain convergency or *bundling up of the orbits at about* 182° *of longitude*. Two new planets having conformed to the view taken since it was first entertained, he thinks it may not be improper to call more decided attention to the circumstance."

By MM. E. Vogel and G. Rümker.

Mean Anomaly ...	55° 4′ 49″·67	July 10, 1851, Berlin M.T.
Long. Perihelion ..	179 9 55·01	Mean Equinox,
— Node	86 51 3·89	Jan. 0, 1851.
Inclination	9 5 47·03	
φ	9 39 47·64	
Log e	9·2249390	
Log a	0·4124446	
Log μ	2·9313397	

Ephemeris. By Mr. N. Pogson, and MM. Vogel and G. Rümker, from their preceding Elements.

For Greenwich Mean Midnight.

1851.	R.A. h m s	N.P.D. ° ′	478·6 Δ. m s	Hor. Par. ″	Log Δ.
July 1	15 33 22	105 31·9			
2	33 12	36·5			0·19555
3	33 3	41·2			
4	32 55	45·9			
5	32 50	50·6			
6	32 46	105 55·5			·20708
7	32 44	106 0·3			
8	32 44	5·2			
9	32 45	10·2			
10	32 50	15·2	13 46·7	5·17	·21891
11	32 54	20·2			
12	33 1	25·3			
13	33 9	30·5			
14	33 19	35·8	14 9·9	5·03	·23095
15	33 31	41·1			
16	33 44	46·4			
17	33 59	51·7			
18	34 16	106 57·1	14 34·1	4·89	·24312
19	34 34	107 2·5			
20	34 54	8·0			
21	35 15	13·5			
22	35 38	19·0	14 59·2	4·75	·25535
23	36 2	24·5			
24	36 28	30·1			
25	36 55	35·8			
26	37 24	41·5	15 24·9	4·62	·26757
27	37 54	47·2			
28	38 26	52·9			
29	38 59	107 58·6			
30	39 34	108 4·3	15 51·2	4·49	0·27974
July 31	15 40 10	108 10·0			

1851.	R.A. h m s	N.P.D. ° ′	478 Δ. m s	Hor. Par. ″	Log Δ.
Aug. 1	15 40 47	108 15·8			
2	41 25	21·6			
3	42 5	27·4	16 18·1	4·37	0·29181
4	42 46	33·2			
5	43 28	39·1			
6	44 12	44·9			
7	44 58	50·8	16 45·5	4·25	·30379
8	45 45	108 56·7			
9	46 32	109 2·6			
10	47 21	8·5			
11	48 11	14·4	17 13·2	4·14	·31557
12	49 2	20·3			
13	49 54	26·2			
14	50 48	32·1			
15	51 43	38·0	17 41·2	4·03	·32719
16	52 39	43·9			
17	53 36	49·8			
18	54 34	109 55·6			
19	55 34	110 1·4	18 9·4	3·93	·33860
20	56 35	7·2			
21	57 36	13·1			
22	58 38	18·9			
23	15 59 41	24·7	18 37·9	3·83	·34978
24	16 0 46	30·5			
25	1 51	36·3			
26	2 57	42·1			
27	4 4	47·9	19 6·5	3·73	·36072
28	5 12	53·7			
29	6 21	110 59·5			
30	7 31	111 5·2			
31	16 8 42	111 10·9	19 35·3	3·64	0·37139

The elements and ephemeris of *Irene* were computed by Mr. N. Pogson at the particular request of the Editor. Mr. Pogson is now attached to the Radcliffe Observatory.

An Ephemeris for $9^h\ 36^m$ Berlin Mean Time, computed by MM. Vogel and G. Rümker from their own elements, was very kindly forwarded by our associate M. C. Rümker, but it was received after Mr. Pogson's Ephemeris was set up. On reducing the Ephemerides to the same date they are so nearly identical, that it has not been thought worth while to print both, as both are only approximate.

HEBE.

HAMBURG. (M. C. Rümker.)

1851.	Hamburg M.T. h m s	R.A. ° ′ ″	Decl. ° ′ ″
July 3	10 40 56	291 44 47·6	−8 8 30·3
5	10 51 9	291 17 32·0	−8 22 0·9

Not corrected for parallax.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

1851.	Green. M.T. h m s	App. R.A. h m s	Exc. of Ephem. s	App. N.P.D. ° ′ ″	Exc. of Ephem. ″	No. of Comps. in R.A.	N.P.D.	Set.
June 17	13 7 48·4	19 38 49·31	...	96 53 44·0	...	15	5	1
26	12 56 56·7	32 45·57	−1·07	97 29 4·1	−4·6	24	8	2
27	13 7 50·9	31 58·07	1·12	34 9·1	3·1	24	8	3
29	12 39 6·5	30 20·85	0·75	44 52·6	4·2	24	8	4
30	12 9 0·8	29 31·42	0·76	97 50 30·1	4·6	24	8	5
July 4	13 0 43·7	25 58·40	1·02	98 15 52·5	4·2	24	8	6
6	10 47 19·5	19 24 13·14	−0·99	98 29 6·0	−5·6	24	8	7

The above observations are corrected for refraction and parallax, and compared with the ephemeris contained in the supplement to the *Nautical Almanac* for 1854.

Mean Places of Stars of Comparison, 1851·0.

Name.	R.A. h m s	N.P.D. ° ′ ″	Set.
Weisse, xix^{h}, 895	19 34 47·33	96 49 15·3	1
B.A.C. 6713	28 52·47	97 21 15·4	2, 3
Weisse, xix^{h}, 689	27 26·87	97 46 52·9	4, 5
— — 621	24 52·78	98 18 40·0	6
— — 561	19 22 36·85	98 29 33·4	7

June 17, clouds troublesome; planet a good 8th magnitude. The six following observations of *Hebe* were all taken under unusually favourable circumstances.

The minutes in declination of Weisse, xix^{h}, 689 should be 50′, not 49′, for 1825; the star is given correctly in Bessel's Zone. Also the precession in R.A. of xix^{h}, 621 should be 3^{s}·255, not 2^{s}·887, which latter corresponds to a + declination.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1851.	Green. M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Comp^{d}—Obs^{d}. R.A. s	N.P.D. ″
July 17	11 14 51·6	19 13 37·57	99 58 45·1	−1·15	−2·9
	11 34 48·0	36·86	51·3	1·24	1·6
18	11 19 57·3	19 12 39·55	100 7 53·2	1·32	1·8
	11 39 53·4	38·72	59·5	−1·29	−0·4

The observations are corrected for refraction and parallax. The parallax and computed places were deduced from the ephemeris contained in the supplement to the *Nautical Almanac*, 1854.

The following is the assumed *mean* place of the star of comparison for 1851·0, derived from the Greenwich and Edinburgh observations:—

	R.A. h m s	N.P.D. ° ′ ″
B.A.C. 6564	19 4 35·76	98 11 1·55

Ephemeris of Parthenope, calculated from the Elements No. III. (Astronomische Nachrichten, No. 763), for Berlin Mean Midnight. By M. Luther.

12h, Berlin Mean Time.

1851.	App. R.A. h m s	Diff. m s	App. Decl. ° ′ ″	Diff. ′ ″	Log. Δ	Diff.	Aberr. Time in Decimals of a Day.	Diff.
July 12	1 40 2·15	1 14·96	+6 8 10·8	+4 49·8	0·32588	223	0·01209	6
13	41 17·11	1 14·17	13 0·6	4 42·8	0·32365	225	0·01203	7
14	42 31·28	1 13·38	17 43·4	4 35·9	0·32140	225	0·01196	6
15	43 44·66	1 12·56	22 19·3	4 28·7	0·31915	228	0·01190	6
16	44 57·22	1 11·73	26 48·0	4 21·6	0·31687	228	0·01184	6
17	46 8·95	1 10·87	31 9·6	4 14·4	0·31459	230	0·01178	6
18	47 19·82	1 10·01	35 24·0	4 7·0	0·31229	231	0·01172	7
19	48 29·83	1 9·12	39 31·0	3 59·7	0·30998	233	0·01165	6
20	49 38·95	1 8·21	43 30·7	3 52·2	0·30765	234	0·01159	6
21	50 47·16	1 7·29	47 22·9	3 44·7	0·30531	235	0·01153	6
22	51 54·45	1 6·34	51 7·6	3 37·1	0·30296	236	0·01147	7
23	53 0·79	1 5·38	54 44·7	3 29·4	0·30060	238	0·01140	6
24	54 6·17	1 4·39	6 58 14·1	3 21·6	0·29822	239	0·01134	6
25	55 10·56	1 3·38	7 1 35·7	3 13·8	0·29583	240	0·01128	6
26	56 13·94	1 2·36	4 49·5	3 5·9	0·29343	241	0·01122	6
27	57 16·30	1 1·31	7 55·4	2 57·9	0·29102	242	0·01116	7
28	58 17·61	1 0·25	10 53·3	2 49·9	0·28860	243	0·01109	6
29	1 59 17·86	0 59·17	13 43·2	2 41·9	0·28617	244	0·01103	6
30	2 0 17·03	58·07	16 25·1	2 33·7	0·28373	245	0·01097	6
31	1 15·10	56·94	18 58·8	2 25·5	0·28128	247	0·01091	6
Aug. 1	2 12·04	55·81	21 24·3	2 17·2	0·27881	247	0·01085	6
2	3 7·85	54·65	10 -3 41·5	2 9·0	0·27634	248	0·01079	7
3	4 2·50	53·47	25 50·5	2 0·7	0·27386	248	0·01072	6
4	4 55·97	52·27	27 51·2	1 52·2	0·27138	250	0·01066	6
5	5 48·24	51·07	29 43·4	1 43·9	0·26888	250	0·01060	6
6	6 39·31	0 49·82	31 27·3	+1 35·4	0·26638	251	0·01054	6
7	2 7 29·13		+7 33 2·7		0·26387		0·01048	

ASTRÆA.

Hamburg. Equatoreal. (M. C. Rümker.)

1851.	Hamburg M.T. h m s	R.A. ° ′ ″	Decl. ° ′ ″	Obs.
May 4	10 36 59·0	217 33 7·3	−5 29 11·0	9
7	10 12 15·3	216 54 22·5	17 27·3	2
8	9 52 0·5	41 57·3	13 56·9	20
10	10 22 39 3	216 16 46·0	5 7 3·1	23
17	10 2 51·3	214 56 56·6	4 48 14·8	18
21	9 54 51·4	214 17 14·0:	−4 41 16·3:	2

Not corrected for parallax.

Mean Places for January 0·1851 of Stars in the Orbit of *Astræa*, deduced from Observations with the Meridian Circle.

R.A.	Precession.	Decl.	Precession.
h m s	s	° ′ ″	″
14 16 28·20	+3·131	−4 38 35·0	−16·60
18 43·78	3·135	49 1·1	16·50
49 27·65	3·136	50 23·5	16·46
25 18·87	3·138	4 49 12·5	16·15
25 22·13	3·142	5 7 56·6	16·15
27 37·53	3·143	10 39·6	16·04
14 31 10·34	+3·144	−5 8 23·4	−15·85

On the Observation of the Solar Spots with large Telescopes.

By the Rev. W. R. Dawes.

"The appearance of the solar spots is greatly modified by the aperture of the telescope employed in observing them. A large aperture, by reducing the telescopic irradiation, produces a hardness and sharpness of outline which cannot be attained by a diminished aperture, and brings out minute details which would never be suspected with a small telescope, however perfect. It may be some time before the admirable suggestion of Sir John Herschel, to make large solar reflecting telescopes with glass mirrors, will be realised, however desirable may be its accomplishment; and even then such instruments will be suited for that purpose only.

"Various methods have been proposed of preserving the darkening glasses, which it is necessary to employ, from the destructive effect of the excessive heat collected by a large object-glass. None of these, as far as I am aware, has proved completely successful. If a combination of coloured glasses is placed at a considerable distance before the eye-piece, so as to receive the rays before they come to focus, according to Mr. Lawson's proposal, the glasses are still exposed to frequent fracture, if the distance from the focus is not very great in proportion to the whole focal length; and if that distance should be much increased, the coloured glasses must be of large size to receive the whole of the rays from the object-glass, and their quality must be nearly as perfect as that of the object-glass itself, or the focal image will be confused and unsatisfactory. But, notwithstanding the objections to the use of this method, its effect on the appearance of the spots and of the sun's disk generally is so striking, as to render it highly desirable that some arrangement should be devised, by which the sun may be examined with an object-glass of the largest dimensions, without the risk of destruction to the coloured glasses, or of injury to the eye of the observer.

"I have lately employed a mode of observation which enables me to use the whole aperture of my $8\frac{1}{2}$-foot refractor ($6\frac{1}{3}$ inches) without the slightest inconvenience. Its simplicity is such as to render it extremely probable that it may already have been employed by other more diligent observers of the sun than myself; but as I have never met with any hint of it, some other observer

may perhaps be glad of a suggestion which will save his glasses and secure the safety of his eye; and thus enable him to enjoy without apprehension the extraordinary phenomena which the sun's surface frequently presents when viewed with a large telescope.

"The method consists simply in *diminishing the aperture in the field-bar* of the eye-piece to any extent which the observer may find requisite or convenient. It is obvious that this does not lessen the brightness of the portion of the sun's image which is visible through the aperture of the field-bar; but by diminishing the area from which light and heat are transmitted to the eye, that portion may be viewed with safety, however large may be the aperture of the object-glass. The field-bar, however, being placed at the focus of the object-glass, will receive all the heat concentrated by it, with the exception of the small portion passing through its central aperture; and it will thus very soon become so greatly heated as, by its contact with the interior of the eye-tube, to render the whole of it very inconveniently hot. This I have obviated in my own telescope by letting the field-bar touch the eye-tube in three points only, the rest of its circumference being filed away; and though with this arrangement some heat is still communicated, it is in no inconvenient quantity. But it might probably be almost entirely prevented by setting the field-bar in some substance which is a bad conductor of heat.

"To determine the largest diameter of the aperture in the field-bar which it may be safe to employ, it is only requisite to decide upon the diameter of an object-glass which might certainly be used without danger. I believe that, under the most intense solar heat in this climate, an object-glass of two inches in diameter will not endanger a well-annealed coloured glass; but any smaller diameter may be adopted as the standard; and whatever that may be, the size of the field-bar in any given instance is readily computed.

"Putting O = diameter of the large object-glass in inches and decimals,
F = its focal length similarly expressed,
o = diameter of standard object-glass considered safe to employ,
d = required diameter of field-bar,

we have $d = \frac{F \times o \times 2 \sin \odot\text{'s } \frac{1}{2} \text{ diameter}}{O}$.

"Thus, in the case of my own refractor, O = 6·34; F = 102·5; and if o be assumed = 2 inches, and the sun's semi-diameter = 16′ 1″, we shall have $d = \frac{102{\cdot}5 \times 2 \times {\cdot}00932}{6{\cdot}34} = 0{\cdot}301$.

"By using a field-bar, therefore, whose diameter is three-tenths of an inch, the heat transmitted to the eye-glass is reduced to that which would be received from the whole disk of the sun, if the diameter of the object-glass were reduced to 2 inches. In my refractor, about one-tenth of the sun's area is the proportion embraced by such a field-bar. But though I believe that this does not exceed

what may be safely admitted, I have usually employed a field-bar of scarcely half that diameter, as being abundantly sufficient for the examination of the largest spots, or even groups of spots.

"In the formula, the eye-piece is supposed to be a convex single lens, or a positive double eye-piece, which, with so small a field of view as the field-bar affords, is quite as convenient as the usual astronomical eye-tube, in which the field lens diminishes the focal image, and in a variable degree with various magnifying powers, necessitating an adjustment of the size of the field-bar to each; while, with the use of single lenses, the power may be varied at pleasure, without changing the dimensions of the field-bar.

"But not only may the minute details of the solar spots be thus examined with all the advantage afforded by the use of a large telescopic aperture. Other very interesting results are also obtainable by the same means. Especially may the heating power of the various parts of the sun's disk be submitted to measurement. And on the occurrence of a solar spot with a large nucleus, by employing a field-bar which would only just embrace that nucleus, the going of the equatoreal driving clock being nicely adjusted, the constitution of the apparently black portion might be examined, and the fact ascertained whether it be actually devoid of light, or whether its light is only so comparatively feeble as to be extinguished by the deep colour of the glass rendered needful by the smallest portion of the sun's bright surface.

"There is one fact to which, though not necessarily connected with the subject of the present paper, I would take this opportunity of drawing attention, as it may, perhaps, be found useful in other observations; and especially in those of some of the phenomena attending a total eclipse of the sun. It is this: *that the same telescopic focus is not equally good on all portions of the sun's surface.* This may be satisfactorily proved when there are well-defined spots near his centre, and also near the edge of his disk: and the difference will be more obvious with a rather low power, such as 40 to 100, on telescopes whose focal length is from 30 to 60 inches. The focus having been accurately adjusted on a spot near the centre, it will be found to require *lengthening* when a spot near the edge is brought into the same part of the field, and *vice versâ*. To ascertain whether this originated in any peculiarity of my own eye, I requested Mr. Hind to try the experiment, without intimating to him on which side the difference of focus lay. He was kind enough to do so, and arrived at precisely the same conclusion as myself. There can therefore be no doubt of the fact; and it is evidently to be attributed to the effect upon the eye of different intensities of light. Indeed I have frequently noticed the same result in passing immediately from one object to another differing much in brightness. Thus, the best focus on the bright edge of the moon will require lengthening when the feebly enlightened portions are brought into the same place in the field of the telescope, or in the examination immediately afterwards of such an object as *Saturn*. And perhaps some of the curious anomalies which have attended

lunar occultations may partly arise from this source. Observers have often stated that, previous to an occultation, the focus of the telescope has been carefully adjusted on a small and close double star: and if, with that focus, the disappearance of a star be observed at the bright edge of the moon, the probability is that, the greater stimulation of the eye having altered its focus, some clinging to the moon's edge, or even projection on its disk, may be the result. The involuntary shortening of the focus of the eye under the stimulus of light, evidently arises from the diminution of the pupil and the consequent drawing forward of the crystalline lens, and is analogous to the variation produced by looking at near and remote objects: but it is very possible that the amount of variation required in the adjustment of the focus of a telescope may differ with different degrees of sensibility in the eye.

"I would beg leave to suggest to those observers who intend to look out for the delicate phenomena attending a total eclipse of the sun, such as Baily's beads and the red flames in the corona, that it might be well to keep this fact in view, which does not appear to be so generally known as it deserves: at least, among those to whom I have mentioned the subject, there was no one who seemed to be aware of it.

"It would seem highly desirable that this or some other equally efficient method of employing the whole aperture should be adopted in observing the sun's transit with large instruments, and in measuring his diameter with large meridian circles and heliometers. The diameter of the sun, as well as of all other celestial bodies, is unquestionably smaller with a large aperture than with a small one, provided the state of the atmosphere is not too unfavourable for its advantageous employment. Though the difference is not so striking on objects having a sensible diameter as on the disks of the fixed stars, yet it exists; and may be readily subjected to experiment in any large telescope whose whole aperture is sufficiently perfect."

Remarks on the Observations of the Obscure Portion of Saturn's Ring, made by Dr. Galle, at Berlin, in the year 1838. By the Rev. W. R. Dawes.

"In the *Astronomische Nachrichten*, No. 756, there is a paper by Dr. Galle, dated 1851, April 1, in which he refers to a communication of Professor Encke's, published in the *Transactions of the Berlin Academy of Sciences* for 1838, as containing some observations on the dark ring of *Saturn*, made by Dr. Galle with the Berlin refractor, which is, I believe, of the same dimensions as the refractor at Dorpat (aperture 9 inches, and focal length 14 feet, Paris measure), and by the same maker.

"On referring to the volume in the Society's library, I found that no part of it was cut open. Professor Encke's paper is illustrated by two pictures of *Saturn*, in which the exterior ring is shown with a broad division at the ansæ, nearly in the middle of

its breadth. But there is no indication in the pictures of any encroachment of the inner ring on the black interval between it and the ball. On looking into the paper itself, however, I find the following remarks on this point by Dr. Galle, who is stated to have been the principal observer with the large refractor in the year 1838.

"'1838, May 8. Air very good. The inner edge of the inner ring is faded.'

"'May 25. The dark space between *Saturn* and his ring seemed to M. Galle to consist, as far as its middle, of the gradual extension of the inner edge of the ring into the darkness, so that the fading of this inner ring has considerable breadth.

"'June 10. The inner edges of the first ring fade away gradually into the dark interval between the ring and the ball. It seemed, if no illusion exists, that the ring, from the beginning of the shading inclusive, extends over nearly half the space towards the ball of *Saturn*.

"'June 15. *Saturn* very distinct. The fading of the inner ring towards *Saturn*, as on June 10.'

"No measurements of this appearance are given in Encke's paper; indeed he does not appear to have seen anything of it himself: and it is to be observed that the pictures refer to the aspect of the planet as seen by him 1837, April 25; and 1838, March 10; being before the observations of Galle, who has recently published (in No. 756 of the *Astronomische Nachrichten*), six days' micrometrical measurements subsequently obtained by himself. These show that he saw the obscure portion of the ring encroaching on the black interval between the ring and the ball to almost precisely the same extent as it appeared to myself at the last apparition of the planet, namely, about 2″. This is a peculiarly interesting fact, as rendering it highly probable that this is really the interior *limit* of the obscure ring. And this idea is supported by the small breadth of the dark line formed by its projection on the ball; which, in fact, appears to be so narrow as scarcely to be consistent with the visible breadth of the dark ring at the ansæ. It is remarkable that no intimation is given by Dr. Galle, that this projection was seen either by himself or any other observer; nor does it appear to have occurred either to Encke, Galle, or Mädler (who is referred to in Galle's observations), that so dull an appendage would be visible as a dark line upon the ball. But, since the ring presented at that time a very broad ellipse, such a dark line would be much broader and more visible than it was last winter. Why then, it may be asked, was it not observed on some of the very favourable nights on which the planet was scrutinised by the observers at the Berlin observatory? I think we may be justified in replying, that *it actually was seen*, but that its nature was not apprehended. For, in both the pictures appended to Encke's paper, there is a dark shading of considerable breadth below, or to the north of, the inner edge of the ring where it crosses the ball, which appears to be intended for the shadow of the ring upon the

ball. But the fact is, that on 1837, April 25, the elevation of the earth above the plane of the ring exceeded the elevation of the sun above the same plane by only 0″·7, according to the data in the *Nautical Almanac*; and consequently the visible shadow of the ring upon the ball must have been an excessively narrow line. And on 1838, March 10, the elevation of the earth above the plane of the ring was *precisely the same* as that of the sun; and there could therefore at that time be *no visible shadow* of the ring upon the planet. The shading in both the engravings must therefore, I imagine, have been *the obscure portion of the ring projected upon the ball*; but it was not recognised as such; and, consequently, the entire phenomenon was not so completely made out as it might have been. Yet Professor Encke seems to have had no doubt of the reality of Galle's observations; for, at the close of his paper, having referred to an observed apparent excentricity of *Saturn's* position in his ring, he uses the following remarkable language:—

"'I find it remarked in my journal on one occasion only, 1837, June 20, $16^h\ 45^m$ sidereal time, that I thought such an appearance was visible, so that the space between *Saturn* and the ring seemed rather greater on the right side in the telescope (the eastern) than on the left (the western). Probably the foregoing remark of M. Galle, that the gradual decrease of light of the inner ring towards the body of *Saturn* appeared to him to extend far into the interval between *Saturn* and the ring, may furnish an explanation. It does not appear that he was on any occasion deceived; since on the four days on which he measured *Saturn*, he has measured the wide extent of the dark covering; and on all the four days found it, with great accordance, of the same dimension. At least it would appear from this, that different eyes are able to see very differently the inner limit of the inner ring; and that even the relative estimation of the proportion of the two ansæ depends upon the observer himself.'

"It is to be regretted that Dr. Galle's observations and measures were not published in the *Astronomische Nachrichten* soon after they were made; as they would long since have directed attention to this remarkable phenomenon.

"It is interesting to remark that at that time the *northern* surface of the ring was visible, while at present the southern is seen; and that it may consequently be inferred, that no appreciable difference exists in the reflective power of the two surfaces of the dull portion.

"In looking for its projection on the ball at the ensuing apparition of the planet, it should be borne in mind, that when the elevation of the earth above the plane of the ring *exceeds* that of the sun, the shadow of the ring on the ball is visible at the interior (or southern) edge of the ring where it crosses the planet; and that therefore the projection of the dark ring, falling upon this shadow, will be invisible. This will be the case till October 18. It may also be much obscured if it should be projected on a dark belt; and it seems very probable that this may often have been the cause

of its having formerly been overlooked. It may even have been mistaken for a very narrow and unusually dark belt; or for a portion of one, the rest being concealed by the bright ring crossing the planet. The position of the ring subsequently to the beginning of last October, was especially favourable to its visibility; for it was projected on to the very bright region extending from the planet's centre towards its north pole, by contrast with which it would appear unusually dark."

On a Photometrical Method of Determining the Magnitudes of Telescopic Stars. By the Rev. W. R. Dawes.

"The magnitudes of telescopic stars are so variously assigned by different observers, as to render it impossible correctly to anticipate the appearance of such an object in a telescope of any particular kind and dimensions, without having reference to the scale of magnitudes adopted by the observer who has assigned the magnitude of the star in question; and even then it is necessary to suppose that his habit of estimating is fixed and tolerably uniform. The differences among observers of great experience and celebrity are much greater than would probably be imagined by those who have not been led to examine the subject, and clearly show that widely different *scales* of magnitude have been adopted; and though, provided each observer's habit of estimation is generally consistent with his own scale, it might not be very difficult to convert the magnitudes of one into those of another, yet the trouble of this is to be deprecated; and the different numerical denominations of the magnitude of the same star create complication and confusion where simplicity and uniformity are especially desirable.

"In examining the estimated magnitudes by different observers, one remarkable fact presents itself; namely, that there is a tendency common to almost all to underrate the magnitudes of stars when seen through a telescope. This is most strikingly exemplified by observations of stars visible with the naked eye, and whose magnitudes may therefore be estimated without telescopic aid. The following instances will afford illustrations of this:—

"*ζ Cancri.* This triple star is obvious to the naked eye, and is designated by Argelander, in his *Uranometria Nova*, as of magnitude 5·4 (or about 4·7). Telescopically its three components have been estimated thus: by Sir James South (S), 7, 8, 8; by Sir John Herschel (H), 8, $8\frac{1}{2}$, $8\frac{1}{2}$; by Struve (Σ), 5·0, 5·7, 5·5: the latter therefore agreeing with Argelander (A).

"32 *Orionis.* Obvious to the naked eye, and designated by A as 5·6 (or about 5·3); by H, $7\frac{1}{2}$ and $8\frac{1}{2}$ (mean of two estimations); by Σ, 5·2 and 6·7, nearly agreeing with A.

"*ζ Aquarii.* A double star whose components are nearly equal, appearing to the naked eye as a bright 4 mag., and designated by

A as 3·4 (or about 3·3); by S, 7 and $7\frac{1}{4}$; by Σ, 4·0 and 4·1, agreeing therefore very nearly with A.

"δ *Serpentis.* A double star, to the naked eye a rather small 3 mag., and by A called 3·4 (= about 3·3). The components are called by Σ 3 and 4, making the star about half a magnitude brighter than A's estimation; while by S they are estimated on *five different nights* as 8 and 9, — being a difference of five magnitudes.

"γ *Virginis.* A well-known double star, whose components are equal; to the naked eye a bright third mag., or, according to A., 3·2 (= about 2·7). By S, estimated on three nights as 8 and $8\frac{1}{2}$, and on one night as $8\frac{1}{2}$ and 9, — being a difference of more than five magnitudes.

"α *Cancri*, by A's naked-eye estimation, is of mag. 4; by Bessel (B) it is telescopically estimated as of the 6th mag.

"κ *Cancri*, estimated with the naked eye by A as of the 5th; telescopically by B, as of the 7th.

"ν *Leonis*, by A's naked-eye estimation, = 5; by B telescopically, = 7.

"The above are a few of the many examples which might be cited from the works of some of the most practised observers. That such stars as δ *Serpentis* and γ *Virginis*, which would by the naked eye be instantly missed from the constellations to which they belong, should be deliberately and repeatedly designated by any practised observer as of magnitudes so small as to be less visible than the planet *Neptune*, is certainly surprising, and strikingly shows the effect occasionally produced on these estimations by the use of a telescope, and especially under high magnifying powers, and perhaps an illuminated field. And it appears that even Bessel has not unfrequently been deceived into estimating stars plainly visible to the naked eye as of only the 7th magnitude.

"It must be acknowledged, however, that it is not very easy for an observer to maintain consistency even with his own scale of telescopic magnitudes, especially under the varying aspects produced by different magnifying powers. And even if it were otherwise, and consistency were usually or easily preserved, the adoption of a different scale by each observer, depending perhaps upon the optical power of the instrument he happens to employ, is productive of great confusion, and requires at any rate that the name of the observer should be affixed to the magnitudes which he assigns, or that the scale he uses should be distinctly stated, in order that some idea may be conveyed of the kind of object we may expect to meet with under the given designation.

"I am not aware upon what principles the scales of telescopic magnitude employed by some of the observers of the most extensive catalogues have been formed. It is evident that Lalande, Piazzi, Bessel, and Argelander, have not referred their estimations to precisely the same standard; the two last, however, differing but slightly, as might be expected from their early association in the Königsberg zone observations. But the adoption of a particular

numerical magnitude to represent a certain degree of brightness has been, as far as I know, purely arbitrary. Even Struve, as we are informed by himself, was led to fix upon the twelfth magnitude to represent the smallest star usually visible in the Dorpat refractor, simply because the number of telescopic magnitudes would thus be the same as those customarily applied to the stars visible with the naked eye. (See Introduction to the *Mensuræ Micrometricæ*, p. lxvii.) Sir J. Herschel has carried his estimation of stars visible in his 20-foot front-view reflector down to the 20th magnitude; and Mr. Bond has done the same in respect to the Munich refractor having an aperture of 15 inches. Here also the limit of visibility appears to have been arbitrarily assigned. Sir J. Herschel has, however, given examples of the different units of his scale from the sixth downwards, in his *Introduction to the First Series of Double Stars* discovered in sweeping with his 20-foot reflector. (See *Memoirs of the Astronomical Society*, vol. ii. p. 464.) And in the Introduction to his Third Series, contained in vol. iii. p. 182, of the *Memoirs*, he says,—'The principle on which I have endeavoured to proceed, in estimating the relative magnitudes of stars below the sixth, is that of continually halving the light of each magnitude to give that of the next inferior denomination; so that, in fact, two stars of the 9th magnitude, so close together as not to be distinguished from one, shall affect the eye as a single star of the 8th,' &c.

"Professor Struve also informs us that he has adopted a somewhat similar plan in assigning the magnitudes of the two components of a double star; with this important variation, however, that a star having half the light of any given magnitude is considered to stand only *half* a magnitude lower in the scale; so that two stars of the 9th magnitude, when viewed with a power too low to separate them, shall affect the eye as one of magnitude $8\frac{1}{2}$; and if a star appearing to the naked eye as of the sixth magnitude were divided by the telescope into two equal stars, each of the components would be considered as of the magnitude $6\frac{1}{2}$; and so on. (See Introduction to the *Mensuræ Micrometricæ*, p. xlii., at the bottom.)

"Now it occurred to me, some years ago, that upon the same principle more completely and extensively carried out, the magnitudes of telescopic stars, or their quantity of light relatively to any given standard, might be pretty accurately determined by a photometrical process. It would certainly be convenient, for the sake of uniformity, that the ratio of light in any two given denominations of magnitude should be generally agreed upon, as the necessity for translating the language of one scale into that of another would be thereby avoided. In the case of the two scales just referred to, the Herschelian assigns a decrease of light according to the powers of $\frac{1}{2}$; while the Struvian assigns a decrease according to the powers of $\frac{1}{4}$; the units of numerical denomination increasing in arithmetical progression. The two scales therefore rapidly diverge, but are easily comparable; yet it would be more convenient if only one were employed.

"The photometrical method which I would now propose is founded on the obvious principle that if there be two stars, A and B, of which B possesses *half* the brightness of A, then will B require *twice* the telescopic illuminating power to render its image equally bright with that of A; and the requisite increase of illuminating power is produced by employing *twice the area* of the object-glass, or object-mirror, which has been found to give to the image of A a definite degree of brightness. Thus the area employed must be inversely as the brightness of the object; and consequently the reciprocal of the area requisite to impart to the image of a star a definite degree of brightness becomes a measure of the intrinsic brightness, or magnitude, of that star.

"In order to the practical application of the proposed method, it is necessary previously to fix upon the magnitude from which to set out, and with which others are to be compared as a standard. To avoid as far as possible the uncertainty attending the denomination of *telescopic* magnitudes, I propose to employ as the standard an average of stars of the *sixth* magnitude, according to Argelander's *Uranometria Nova*. This may be taken as the limit of steady visibility by the average of *unassisted* vision on ordinary clear nights; and this *limit of steady visibility* is the *definite degree of brightness* to which all objects must be brought up in comparing their magnitudes with the standard magnitude.

"The next point to be determined is the *telescopic aperture* requisite for rendering average stars of the sixth magnitude just steadily visible. From theory it might readily be concluded, that, as *both* eyes are employed in unassisted vision, and as also much light is lost by reflection at the eight surfaces presented by the double object-glass and double eyepiece of an achromatic telescope, to which, moreover, only *one* eye is applied, it would require an achromatic aperture considerably *larger* than the pupil of the eye to meet the proposed conditions, especially when a magnifying power is employed which is large, compared with an aperture whose diameter is only two or three tenths of an inch. But experiment proves that in this case, as in many others, some circumstances, with which perhaps we are but imperfectly acquainted, greatly modify the deductions to which theory would lead. My experiments have been conducted principally with the finder of my Munich equatoreal, having an aperture of 1·53 inch, a focal length of 20 inches, and a magnifying power of $16\frac{1}{2}$. Assuming that the pupil of my eye might probably be 0·2 of an inch in diameter, when stimulated by no more light than that of a clear moonless night, I employed an aperture of a quarter of an inch as making a fair allowance for the loss of light, the magnifying power, and the use of only one eye in observing. This aperture, however, proved to be much too large. stars of the sixth magnitude being far more than only just steadily visible with it. After various experiments, an aperture of 0·15 of an inch was fixed upon; and with this and the usual power of $16\frac{1}{2}$, a list of 21 sixth-magnitude stars from Argelander's *Uranometria Nova* were examined. Of these, 9 ap-

peared to be of precisely the standard brightness, being just steadily visible; 7 were rather too bright, and were estimated to be of magnitudes from one to five-tenths of a unit brighter than the sixth; while the remaining 5 were rather too faint, and were estimated at from 6·1 to $6\frac{1}{4}$. The mean of the whole gave D = A − 0·04, or 6 D = 6·04 A. The average estimation may, therefore, be considered as identical.

"It is, however, obvious that the various degrees of sensibility of the optic nerve in different persons must render it necessary for each observer to determine experimentally for himself what aperture of the telescope he uses is requisite to give the desired visibility to average stars of the sixth magnitude; and from that to determine the apertures corresponding to the lower magnitudes. In all such cases the telescope and the observer's eye must be considered as constituting one compound optical instrument.

"It was at first my intention to adopt Sir J. Herschel's scale, as generally avoiding the use of half-magnitudes; but it immediately appeared that the magnitudes thus determined would be widely different from those adopted by the principal observers of extensive star-catalogues, especially Lalande, Piazzi, Bessel, and Argelander. I have, therefore, adopted Struve's ratio of progression, according to which, as will appear hereafter, the magnitudes assigned by the proposed method very nearly agree with the average estimations of the great observers just mentioned; and this I considered a sufficient reason for giving it the preference.

"Let, then, the numerical magnitudes of telescopic stars be assumed, so that one star of the sixth magnitude shall equal two stars of magnitude $6\frac{1}{2}$; and one star of magnitude $6\frac{1}{2}$ = two stars of magnitude 7, and so on. Then, putting m = the standard magnitude; a = the aperture necessary to show it; μ = any other inferior magnitude, expressed as usual by a larger numerical denomination; and α = the corresponding aperture necessary to render visible a star of the magnitude μ, we have $\alpha = a \cdot 2^{\mu - m}$; by which formula the apertures in the following table, corresponding to the different magnitudes in the scale may be computed; 0·15 of an inch being the standard aperture corresponding to magnitude 6, *suited to my own eye.* I add also the corresponding apertures of reflecting telescopes of various constructions, the ratio of an equally illuminating aperture to the aperture of an achromatic refractor being assumed in the Herschelian, or front view, as 6 to 5; in the Newtonian, as 7 to 5; and in the Gregorian, as 8 to 5.

Ɛ's Magnit.	H's Magnit.	Achromat. Aperture. inch.	Front View Aperture. inch.	Newtonian Aperture. inch.	Gregorian Aperture. inch.
6	6	0·15	0·18	0·21	0·24
$6\frac{1}{2}$	7	0·21	0·25	0·30	0·34
7	8	0·30	0·36	0·42	0·48
$7\frac{1}{2}$	9	0·42	0·51	0·60	0·68
8	10	0·60	0·72	0·85	0·96

Σ's Magnit.	H's Magnit.	Achromat. Aperture. inch.	Front View Aperture. inch.	Newtonian Aperture. inch.	Gregorian. Aperture. inch.
8½	11	0·85	1·02	1·20	1·36
9	12	1·20	1·44	1·70	1·92
9½	13	1·70	2·04	2·40	2·72
10	14	2·40	2·88	3·39	3·84
10½	15	3·39	4·07	4·80	5·43
11	16	4·80	5·76	6·79	7·68
11½	17	6·79	8·15	9·60	10·86
12	18	9·60	11·52	13·58	15·36
12½	19	13·58	16·29	19·20	
13	20	19·20	23·04	27·15	
13½	21	27·15	32·58	38·40	
14	22	38·40	46·08	54·31	
14½	23	54·31	65·17	76·80	
15	24	76·80	92·16	108·61	

" In computing such a table, however, with any magnitude and corresponding aperture as the standard, the numbers may be more readily deduced from the standard aperture than by computing each by the formula. For the apertures suited to the succeeding units of magnitude below the sixth are deduced from the aperture suitable to the sixth, by continually multiplying by 2. The aperture adapted to the first half-magnitude below the sixth is obtained by multiplying the aperture for the sixth magnitude by the root of 2 (= 1·4142). And for the succeeding half-magnitudes the aperture thus found for magnitude 6½ is also continually multiplied by 2.

" As an example of the computation by the formula of the numbers expressing the achromatic apertures in the above table, let it be required to find the aperture (α) corresponding to the 12th magnitude in Struve's scale.

" Here $m = 6$; $a = 0{\cdot}15$; $\mu = 12$; $\mu - m = 6$; and $\alpha = a \cdot 2^{\mu - m} = 0{\cdot}15 \times 2^6 = 9{\cdot}6$.

" It is very remarkable that the aperture thus determined to be requisite for rendering just visible to my own eye a star of Σ's 12th magnitude, should be precisely the aperture of the Dorpat refractor to which Struve has arbitrarily assigned that magnitude as the smallest visible on ordinary nights.

" Putting H = the numerical magnitude according to the Herschelian scale, and Σ = the numerical magnitude according to the Struvian scale, we have the formula, $H = 2\Sigma - 6$, by which the Struvian are converted into the Herschelian; and the formula, $\Sigma = \frac{H + 6}{2}$, by which the Herschelian are deducible from the Struvian.

" It must be acknowledged that the magnitudes actually

assigned by Sir John Herschel to double stars discovered in his sweeps, frequently differ considerably from those to which they are entitled according to the comparative scale in the above table. Yet from several circumstances I am led to attribute this difference mainly to the great difficulty, amounting almost to impossibility, of assigning the proper place in the scale to objects differing so greatly in brightness as do the stars within the compass of the front view 20-foot reflector; and especially when caught hastily during sweeps, the principal objects of which are of quite another character. In several remarkable instances, however, where, from some particular interest attaching to the object, the magnitudes have been carefully estimated, the agreement of the estimation with the numbers in the table is striking. As examples, we may cite some of the objects specially mentioned by Sir John in his *Introduction to his Third Series*, as probably not within the reach of the Dorpat refractor. (*Mem. Ast. Society*, vol. iii. p. 182.) Of these, M. Struve selected three for examination, viz. *κ Geminorum*, *ξ Pegasi*, and *α² Cancri*. Of *κ Geminorum* the small companion is stated by H to be of magnitude 14; Σ assigns to it magnitude 10. *ξ Pegasi* is of magnitude 5 and 18, according to H; of 5 and 12, according to Σ. In these two instances the estimation of brightness is *identical;* the numerical difference of magnitude being precisely what the two scales require. To *α² Cancri* H assigns $4\frac{1}{2}$ and 20; Σ does not give his magnitudes; but having measured both the position and distance with the Dorpat telescope, the magnitude he would assign is certainly not below the 12th, perhaps about $11\frac{1}{2}$, which would agree with 17 H. Subsequently, the companions both of *ξ Pegasi* and *α² Cancri* were stated by H to be of 16 mag. (See *List of Test Objects* in *Mem. Ast. Society*, vol. viii. p. 31.) And this shows the difficulty of rightly designating these *intensiva* of faintness, without some photometrical standard, to which from time to time recourse may readily be had; for, according to the Herschelian scale, one star of the 16th magnitude is equal to 16 stars of the 20th. To these may be added the faint companion of *τ Boötis*, to which H assigns 16 mag. By my method it appears to be of magnitude $11\frac{1}{4}$, which corresponds to $16\frac{1}{2}$ H. In the comparative table, however, drawn up by Sir John Herschel from about 500 comparisons of the magnitudes assigned by himself in his sweeps, and by Struve, in his large catalogue of double stars (*Mem. Ast. Society*, vol. iii. p. 180), the *average* difference is found to be only about one magnitude. So far, then, from the magnitudes of the smaller stars having been usually underrated by Sir John, the deviation from his own scale seems to have been decidedly in the opposite direction, and, as has been pointed out by himself, gradually increasing. (*Mem. Ast. Society*, vol. vi. p. 80.)

"Mr. Bond carries his numerical designation of the magnitudes of stars visible with the refractor of 15 inches in aperture, down to 20. His scale, therefore, appears so nearly to agree with the Herschelian that it may be deemed practically identical. For by the

formula, $\alpha = a \cdot 2^{\mu - m}$, we find, that when $m = 6$, $a = 0{\cdot}15$, and $\alpha = 15$, the value of $\mu = 12{\cdot}64$, which is the magnitude according to Struve's scale; and this converted into the Herschelian scale $= 19{\cdot}28$; sufficiently near to 20 to require no further correction.

"But it is especially a matter of interest to ascertain how far the magnitudes, photometrically determined by the plan now proposed, agree with those which have been employed by the observers of the most extensive star-catalogues. To this end I have examined a considerable number of objects taken from Baily's edition of the *Hist. Cél.* of Lalande, from Weisse's Bessel, and from Argelander's zone observations. My selected working catalogues contained only the right ascension and declination of the objects, without any intimation of their magnitudes, and were arranged in the order of right ascension. The proper apertures, adapted to the case where $m = 6$ and $a = 0^{m}{\cdot}15$, having been cut out of card-board and laid out on a table in the observatory, the equatoreal was set to the place of the object; an estimation made of its magnitude from its appearance in the finder, in the first place without diminution of its aperture; and then such a diminishing aperture selected by trial as reduced the brightness of the object to the lowest point compatible with keeping it steadily in view when the eye was directed fully upon it. The designation of the star, with the aperture suitable to it, and the corresponding magnitude, were immediately entered in my journal; and it appeared that the finding of each object, determining its magnitude, and recording the particulars, occupied from three to four minutes: so that from fifteen to twenty could be thus determined in an hour. The nights devoted to this work were invariably those whose quality was not suitable for micrometrical operations, though apparently free from any considerable quantity of haze.

"In the following table, the first column, under the initial D, contains the magnitude, as determined by the proposed method; in the second column is stated the whole number of stars of each magnitude which have been used in the comparisons. The third column, under the initial B, contains the average corresponding magnitude attributed by Bessel to the stars whose number is given in the fourth column; the fifth and sixth columns contain the corresponding magnitudes and the number of stars from Argelander; and the seventh and eighth columns contain similar quantities from Lalande. The ninth column contains the differences between the magnitudes assigned by me and the mean of the corresponding magnitudes from Bessel, Argelander, and Lalande; and the tenth column contains the results of comparison of my magnitudes with the mean of Bessel and Argelander only. The stars from Lalande are all included among those taken from Bessel and Argelander. The whole number of stars compared is 187; of which 92 are from Bessel, and 95 from Argelander; and 81 are also found in Lalande.

D.	Stars.	B.	Stars.	A.	Stars.	L.	Stars.	$D-\frac{B+A+L}{3}$	$D-\frac{B+A}{2}$
7·0	19	7·00	12	6·97	7	6·53	15	+0·17	+0·01
7·5	30	7·47	16	7·44	14	7·47	23	+0·04	+0·05
8·0	51	8·15	26	8·09	25	8·17	25	+0·14	−0·12
8·5	50	8·69	24	8·37	26	8·43	13	0·00	−0·03
9·0	37	8·99	14	8·86	23	8·70	5	+0·15	+0·08

"The only discrepancy of any consequence among the numbers in the table occurs in Lalande's estimations of stars which I have designated of the 7th magnitude. The difference amounts to nearly half a magnitude, and arises from the frequency with which Lalande has assigned the 6th magnitude to stars not contained in Argelander's *Uranometria*, and certainly not ordinarily visible to the naked eye. There is also a difference of 0·3 of a unit in the same column corresponding to my 9th magnitude; and the cause of this is found partly in Lalande's having more rarely used 9 as a designation of magnitude than either Bessel or Argelander has done; and partly, no doubt, in the small number of stars (only 5) of that magnitude found in Lalande among the stars compared.

"On the whole, the agreement of the magnitudes determined by the proposed method, with those employed by the three great zone observers, is far more close than I could have ventured to anticipate; and constitutes a strong additional recommendation of it on the ground of uniformity, so especially desirable in this department of practical astronomy.

"It has been supposed that the magnitudes assigned by Struve to the objects contained in his great Dorpat catalogue are usually much too high. Tested by my photometrical method, the average difference between his estimations and my own is rather more than one quarter of a magnitude, by which quantity his magnitudes are higher than mine. By comparison of 74 stars common to Struve and Bessel, between the sixth and ninth magnitudes, the mean difference results, $\Sigma = B - 0{\cdot}40$. And by 32 telescopic stars common to Struve and Argelander the average difference comes out, $\Sigma = A - 0{\cdot}46$; by which quantities, 0·40 and 0·46 respectively, Struve's magnitudes are higher than Bessel's and Argelander's. A comparison, however, of 80 stars in Argelander's *Uranometria*, from the 3d to the 6th magnitude, gives the mean difference in the estimations of those stars, $\Sigma = A - 0{\cdot}005$ only. From the moderate number of stars compared in the above cases, the conclusions can be received only as showing the tendency; yet so great is the consistency and uniformity of estimation by these eminent observers, that I doubt if the results would be greatly modified by a more extensive comparison. And they are sufficient to show that the proposed method of photometrical determination gives results holding a middle place among those of the most careful and accurate observers, and differing from any of them on an average by only a small fraction of a unit of the scale adopted.

"One great recommendation of the method of apertures for the

determination of magnitudes consists in the case with which it is employed; requiring no new instrument or eye-piece, or any variation in the arrangement of the telescope or its eye-pieces, which may be in use at the time. Nothing more is wanted than a few circular apertures neatly cut out of card-board, and of such a size as to be applied to the object-end of the finder, for the determination of magnitudes, as far as that instrument will extend. The only difficulty or inconvenience attends the application of various apertures to the object-end of large telescopes without disturbing the instrument. This, when the telescope is a refractor of considerable focal length, requires some special contrivance, which, however, is of a very simple character. If near the extremity of the dew-cap a small ledge or shoulder be made in the inside, the apertures corresponding to the magnitudes beyond the power of the finder may be easily raised to their place by a hook of suitable shape at the end of a light wand of sufficient length; and thus the telescope may remain unmoved from the object.

"The same effect which it is proposed to produce by the application of various apertures before the object-glass might be attained by the use of very small eye-holes; precisely the same phenomena occurring as when the aperture of the telescope is diminished at the object-end. It is obvious that when the eye-hole is less than the emergent pencil, its effect is to cut off part of the rays transmitted by the object-glass; and if the eye-hole be duly proportioned to the magnifying power employed, any required aperture may be taken into use and the rest excluded. But though this is a neat and handy mode of diminishing the aperture, there are two grave objections to its use. The first is the difficulty of making eye-holes of precisely the proper size for bringing into use a definite portion of the object-glass; and the second and still more serious objection is, that the same eye-hole will cut off different portions of the object-glass with different magnifying powers; and, consequently, it would always be necessary to employ the same magnifying power, or else to have various sets of eye-holes adapted to the powers usually employed. And thus a complication and difficulty would arise sufficient in most cases to prevent the use of the method altogether.

"I may here mention a plan by which I have succeeded in measuring pretty accurately the diameter of the pupil of my own eye when exposed to no other light than that of the stars. I am not aware that this has hitherto been done. An aperture of about 0·2 of an inch has been assigned to the pupil as probably near the truth on an average; though it no doubt varies considerably in different individuals: but I believe this is not founded on experiment, which indeed may seem to be rendered impossible by the absence of sufficient light. The method I employed is this. Being very short-sighted (requiring the use of Dollond's No. 9 concave), the image of a bright star on the retina of my eye is a luminous disk of large diameter. If a small hole in a card be held close to the eye, the diameter of this luminous disk will be diminished when

the hole is smaller than the pupil; but when the hole is precisely of the same size as the pupil, the whole of the disk will be included, provided the hole and the pupil are concentric; but the slightest movement of the hole in any direction will cut off a portion of the luminous disk on the opposite side, and change the circular disk into a gibbous one. With a little care the experiment may be made with great nicety; a difference of one or two hundredths of an inch in the size of the hole being immediately perceptible in the effect. By this means I have ascertained the pupil of my eye by starlight to be, as nearly as possible, one quarter of an inch. It is obvious that a person who is not short-sighted may try the same experiment by the use of a convex lens.

"It has occurred to me in the course of these experiments, that diminishing apertures applied to the naked eye might be employed in the determination of star-magnitudes higher than the sixth. It is evident that the scale I have adopted for the lower magnitudes will not apply to these. Calculated by the same formula, the aperture with which a star of the second magnitude should be visible is only the hundredth of an inch. This is much too small: yet with this aperture, *Sirius* is steadily visible, and appears with a planetary disk as if seen through a telescope with a high power in proportion to the aperture. On viewing the sun, and also the full moon, through this extremely small hole, a curious phenomenon presents itself. The edges of their disks are softly defined, and are surrounded by a well-formed bright ring, precisely similar to the first luminous ring round the disk of a bright star viewed with a fine telescope and high power. This is still seen when the hole is as large as the fortieth of an inch in diameter; and this agrees with the telescopic fact, that the emergent pencil must be reduced to about the same size before the ring round a star is separated from its disk. Of course, a moderately dark glass will be required for observing this phenomenon on the sun; and in all cases the edges of the hole should be clean and smooth.

"It might be supposed that in the determination of magnitudes by the use of various apertures on a telescope, the results would be perceptibly affected by the magnifying power employed. But experiment does not support this notion. The mere visibility of stars, even of the faintest, is but slightly affected by the power employed, provided always that the air is pure and the moon absent, or not within 40° or 50° of the object. Indeed, it is a fact that an increase of power brings out many small stars which were invisible with a lower magnifier. But this has its limits; and there is a certain ratio of illuminating and magnifying power which is both more pleasant to the eye and more efficient than any other. This I believe to be attained when the diameter of the emergent pencil is about 0·02 of an inch. Consequently, the power 16½ on my finder is too great to be the most efficient for the apertures below 0·3 of an inch; and when the aperture is reduced to 0·15 of an inch, and the diameter of the emergent pencil is therefore only 0·009 of an inch, the appearance of a star of the sixth magnitude,

to which that aperture corresponds, resembles that of a faint planetary nebula. But this is quite consistent with the object being steadily seen when the eye rests upon it; just as a dull planet, such as *Saturn*, viewed with a telescope in full sunshine, may perhaps not be seen at all till the eye has for some time searched over the field of view; yet, after being caught sight of, it remains steadily visible when the eye is directed fully upon it. Generally, however, a lower power, as 8 or 10, might be more agreeable and less fatiguing to the eye when the aperture employed is less than 0·3 of an inch. And this may be especially desirable in determining the standard aperture for stars of the sixth magnitude, from which the apertures suitable to the inferior magnitudes are to be deduced.

"It is interesting and desirable to ascertain the magnitude of the smallest star visible in a telescope of any given size and construction; and this may readily be deduced from the formula. For since $\frac{\alpha}{a} = 2^{\mu - m}$, the value of μ for any given values of α and a may be found. Adapting the formula to logarithmic computation, we have $\mu = \frac{\log \alpha - \log a}{\log 2} + m$. If, for example, it be desired to know precisely what magnitude should be attributed to the *minimum visibile* in my $8\frac{1}{2}$-foot refractor, whose aperture is 6·34 inches; where, as in my own case, $a = 0{\cdot}15$ when $m = 6$, we have $\mu = \frac{0{\cdot}8021 - 9{\cdot}1761}{0{\cdot}3010} + 6 = 11{\cdot}34$, the magnitude sought, according to the Struvian scale. And since $H = 2\Sigma - 6$, the corresponding Herschelian magnitude = 16·68. In like manner the *minimum visibile* in the finder of my equatoreal = 9·35 $\Sigma = 12{\cdot}70$ H. And a star only visible by fits, or steadily visible only on extraordinarily brilliant nights, may be safely denominated of $9\frac{1}{2}$ magnitude.

"It is obvious that any numerical magnitude and its corresponding aperture suited to the ocular sensibility of any observer, may be made the standard; or may represent m and a respectively. And as the management of very small apertures on a telescope armed with a comparatively high power, is less easy than that of the larger apertures with the same power, it may be found by some observers more satisfactory to fix upon another magnitude (the 8th, for instance), as the standard, and to compute the numbers of their table of apertures from the aperture suitable to their eye for that magnitude. The formula I have given, being general, applies equally to this mode of proceeding; but for higher magnitudes than the standard value of m, whatever that may be assumed, the exponent of the power of 2 will be negative; the numerical value of μ being less than that of m. For this purpose, a list of stars whose magnitudes have been carefully determined, and conveniently situated for comparison at different times of the year, may form a desirable appendix to this communication, which I hope at some future time to do myself the pleasure of presenting to the Society."

Extract of a Letter from Father A. Secchi, Director of the Observatory of the Collegio Romano.

"I have repeated M. Léon Foucault's experiment with a pendulum 31 metres long, and a weight of 28 kilograms; I have measured the angles with the greatest care, and have constantly found the deviation such as it should be according to theory. There is, however, a slight difference in the motion at the beginning and end of the series: at the beginning the angles are a few minutes in excess, and at the end a few minutes in defect. The errors, to be sure, are not larger than the probable errors of observation; but as they are constantly the same way, they seem to indicate a physical cause. They can have no effect to destroy this proof of the rotation of the earth. I have not completed the reduction of these observations; but the length and number of my series, some of which lasted six hours, leave no doubt at all as to the conclusion. I am surprised, therefore, to see that some English journals cast doubt on the correctness of this demonstration; but I presume these objections do not come from your men of science."

A Method of Delineating graphically M. Foucault's Pendulum-experiment demonstrative of the Earth's Diurnal Rotation. By J. Drew, Esq., *Phil. Doct.*, &c.

Mr. Drew conceives that the problem of the apparent rotation of the plane of a vibrating pendulum, with respect to the azimuthal plane at any point of the earth's surface, in consequence of the diurnal rotation, may be rendered clearer by the following graphical method of considering it:—

Draw the circle of latitude for the place at which the experiment is made, and imagine the cone enveloping the earth's surface at this circle to be also drawn. The apex of this cone will be in the earth's axis produced, and the length of its side will be the earth's radius × cot. lat. of place.

Draw horary lines from the apex of the cone to the base or circle of latitude; then, if the sheet of the cone be imagined to be developed into a plane, the successive angles formed by the radial or horary lines with the initial radius representing the initial plane of vibration will represent the corresponding angles of revolution of the pendulum with respect to the azimuthal plane.

Now, the first of these angles,

$$= \frac{\text{subtending arc}}{\text{length of side of cone}}$$

$$= \frac{\text{equatoreal arc} \times \text{cos. lat.}}{\text{rad.} \times \text{cot. lat.}}$$

$$= 15^\circ \times \text{sin. lat.}$$

This, then, neglecting the small quantities that enter into the

rigorous solution of the problem, is the angle described by the plane of the pendulum in one hour of the earth's rotation, and Mr. Drew proposes to mark off angles equal to this through the whole circumference of the circle formed by the developed cone, and to draw lines through the points of the circumference thus formed parallel to that radius which represents the initial plane of vibration. If the cone be then made to envelope the sphere again, the lines thus drawn will represent to the eye the directions in which the pendulum will be swinging at each successive hour of departure from the initial plane during a whole day.

In the course of the evening, Mr. Sheepshanks gave a hurried account of the methods which he had adopted for graduating standard thermometers. Professor Piazzi Smyth made some remarks on reflecting instruments, with suggestions for their improvement. The substance of these lectures will probably form part of a supplementary *Notice*. This *Notice* will contain two other papers. These have been postponed from the present Number, *as they would have doubled the postage.*

London:—Printed by G. Barclay, Castle St. Leicester Sq.